PI MU EPSILON JOURNAL

THE OFFICIAL PUBLICATION OF

THE HONORARY MATHEMATICAL FRATERNITY

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OF THE HONORARY MATHEMATICAL FRATERNITY

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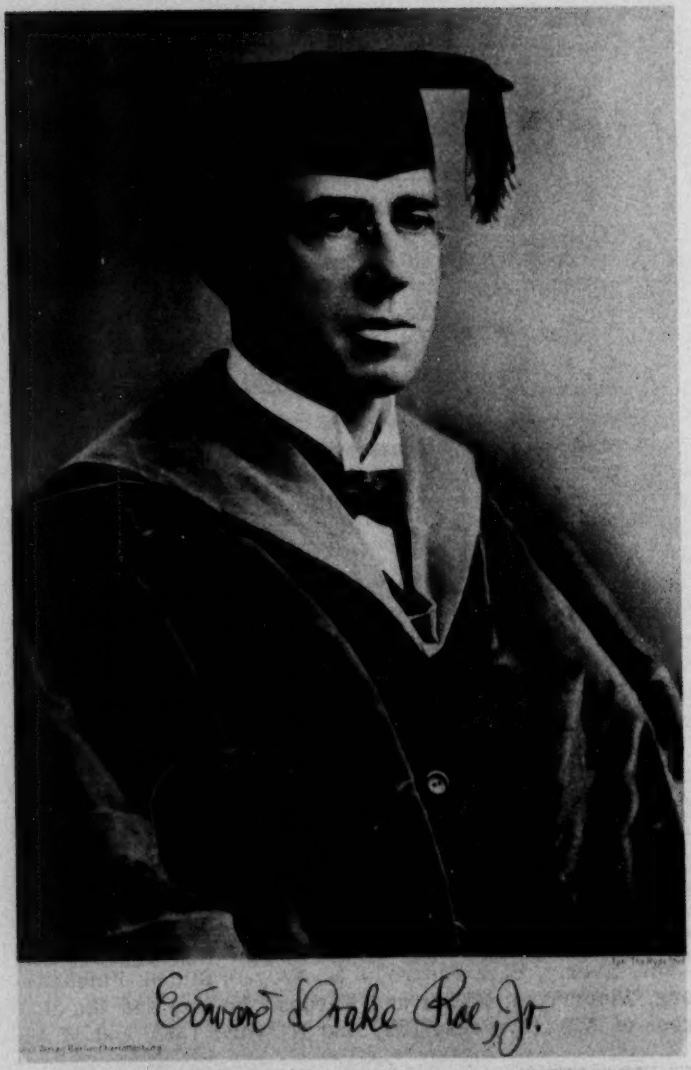

FOUNDER OF THE PI MU EPSILON FRATERNITY
INCORPORATED AT ALBANY, N. Y., MAY, 1914

BIOGRAPHY

PROFESSOR EDWARD DRAKE ROE, Jr.

By May Naramore Harwood,*
Syracuse University

When Pi Mu Epsilon was founded at Syracuse University, the founder envisaged that, when it became a national organization with chapters in the leading universities and colleges of America, there would be both a desire and a need for the fraternity to have its own publication to knit the chapters more closely and to provide an outlet for papers not otherwise likely to be published. Now that this part of the vision is being fulfilled it is fitting that a portion of the first issue of the publication be given to a sketch of the life and works of the man to whom the vision was given — Professor Edward Drake Roe, Jr. Professor Roe never doubted that Pi Mu Epsilon, once started, would flourish and the present large number of its widely distributed chapters would be no surprise to him.

Edward Drake Roe, Jr. was born at Elmira, N. Y. on the fourth of January, 1859, son of Edward Drake Roe, landowner, and his wife Eleanor Jane Roe, née Frost. He was educated at the Elmira Academy and at Syracuse, Harvard and Erlangen universities where he studied under such well known teachers as French, Haven, Bennett, Coddington, Smalley, Brown, Comfort, O. W. Holmes, H. P. Bowditch, T. Dwight, Fitz, Wood, Hills, C. S. Minot, Bowen, Lovering, Royce, Byerly, B. O. Pierce, J. M. Pierce, Simon, Falckenberg, Widermann, Nöther and Gordan. He obtained the degrees of A.B. (Syracuse 1880 and Harvard 1885) and M.A.

*Charter member.

(Harvard 1886). He was associate professor of mathematics at Oberlin College from 1892 to 1899. Oberlin granted him a leave of absence for three years (1897 - 1899 inclusive) during which leave he went to the University of Erlangen, Bavaria, where he won his doctorate in 1898. He then returned to America and in 1901 was awarded the John Raymond French Chair of Mathematics at Syracuse University and some years later was appointed director of the Holden Observatory at Syracuse.

Professor Roe's interest in astronomy was so great that in 1906 he erected on his own grounds a private observatory equipped with an Alvan Clark equatorial telescope, a superb 6-1/2 inch refractor with an objective by Ludin, a driving clock by Kandler, a micrometer by Gaertner, and several other smaller instruments. His observatory was considered one of the best equipped private observatories in the country. After his death, this observatory with all the equipment was given to Harvard College. In it he had found his recreation; besides making many observations of the sun, moon, planets, and comets, he discovered and measured 75 double stars.

Professor Roe so loved the observatory on the Syracuse campus that he held many of his graduate classes there. In a class in quarternions, the three students knew one another as Alpha, Beta and Gamma and the twinkle in Professor Roe's eyes showed that he understood that a fourth Greek letter was often added. A well-filled key ring gave evidence of his care of the observatory and he was quick to catch the implication when a student expressed astonishment on finding an unlocked compartment containing crayon and dustcloths.

In 1904, Professor Roe attended the Third International Congress of Mathematicians and toured the German universities.

Professor Roe was the author of many scientific articles on mathematics, astronomy and philosophy. He was coauthor of a text book in trigonometry and one in algebra. He was the founder and director-general of the honorary mathematical fraternity, Pi Mu Epsilon, and was a member of Phi Beta Kappa, Sigma Xi, Pi Kappa Phi, and Delta

Kappa Epsilon. He was a fellow of the American Association for the Advancement of Science, a member of the American Mathematical Society, the founder and president of the Syracuse Astronomical Society, a member of the Deutsche Mathematiker Vereinigung, Circolo Matematico di Palermo and Société Astronomique de France.

In appearance, Professor Roe was outstanding — tall, erect, spare and handsome; he dressed conservatively, usually in gray with ties of Harvard red. Coming across the campus in winter, in his long dark fur lined coat, a tall fur cap on his iron gray hair, his green felt book bag under his arm, and his rugged face reddened by the wind and snow, he was a goodly sight. The fur cap evidently was a treasure. On removal, when the snow and dampness were carefully brushed from its plushy surface, it was meticulously folded and placed in a desk compartment reserved for its concealment and protection. In this desk, too, during the early years of Pi Mu Epsilon, was stored the seal of the fraternity and on proper occasions this seal was used by Professor Roe himself to stamp the certificates of membership. Other parts of his desk, like desks of many scholars, were piled with all sorts of papers, letters, notices, class notes, catalogues and manuscripts — seemingly in hopeless confusion; but Professor Roe's fingers went to any desired object like steel to a magnet. His hands were most attractive. They were strong capable hands with long sensitive fingers, on one of which he wore an unusually fine and brilliant diamond ring. Difficult it was to decide whether the ring adorned the hand or the hand enhanced the beauty of the gem.

By his first wife Professor Roe had one daughter, Mrs. E. H. Gaggin of Syracuse. Some years after the death of his first wife he married Josephine Robinson, teacher of mathematics at Berea College in Kentucky. She loved the science of mathematics as did her husband and earned her doctorate at Syracuse in that field.

Professor Roe was for twenty-nine years a teacher of mathematics at Syracuse University. Throughout his years of service as a teacher, he always stood for the highest ideals of intellectual honesty and scientific achievement. He stood for high scholarship, thorough scientific study and research.

He impressed all who knew him as a scholar and teacher with a deep thirst for knowledge and an earnest desire to impart it with perfection. He worked with untiring patience in mathematics and its allied science astronomy in the University and in the community.

Professor Roe was the embodiment of character. He was a devoted teacher, a deep thinker, a philosopher and an earnest Christian. He died quite suddenly at his home on December 11, 1929. In his death Syracuse University and the scientific world suffered a distinct loss.

The following is a list of the published works of Professor Edward Drake Roe, Jr.

"The Probability of Freedom: A Critique of Spinoza's Demonstration of Necessity," Bibliotheca Sacra, Vol. LI, No. 204, 1894

"Trigonometry for Schools and Colleges" (with Professor F. Anderegg), Ginn and Co., 1898

"Two Developments," American Mathematical Monthly, Vol. IV, No. 3, 1897

"On the Circular Points at Infinity," American Mathematical Monthly, Vol. IV, No. 5, 1897

"Note on Integral and Integro-Geometric Series," Annals of Mathematics, Vol. II, No. 6, 1897

"Note on a Formula of Symmetric Functions," American Mathematical Monthly, Vol. V, No. 6-7, 1898

"Die Entwickelung der Sylvester'schen Determinante nach Normalformen," Leipzig, B. G. Teubner, 1898

"On Symmetric Functions," American Mathematical Monthly, Vol. VI, Nos. 1-6, 1899

"On the Transcendental Form of the Resultant," American Mathematical Monthly, Vol. VII, No. 3, 1900

"On a Formula of Interpolation," American Mathematical Monthly, Vol. VIII, No. 1, 1901

"On Symmetric Functions," American Journal of Mathematics, Vol. XXV, No. 1, 1903

"Note on a Partial Differential Equation," Annals of Mathematics, Vol. 4 (second series), 1902/03

"Selected Chapters in Algebra" (with Dr. W. G. Bullard, Syracuse), E. C. Johnson, 1903

"On the Convergence and Divergence of Some Particular Series," Syracuse University Bulletin, Series IV, No. 1, 1903

"On the Coefficients in the Product of an Alternant and a Symmetric Function," Transactions of the American Mathematical Society, Vol. 5, No. 2, 1904

"On the Coefficients in the Quotient of Two Alternants," Ibid., Vol. 6, No. 1, 1905

"On Complete Symmetric Functions," American Mathematical Monthly, Vol, XI, Nos. 8-10, 1904

"The Effect of Wind Forces on an Observatory Dome," Popular Astronomy, Vol. XIV, No. 6, 1906

"On Mathematics, Secondary Education," Bulletin 31, Albany, N. Y., 1906.

"On Sunset at Sea, Great Sun Spots, and the Transit of Mercury," Popular Astronomy, Vols. XIV, XV, XVI, 1906/08

"Fifteen Communications to the English Mechanic and World of Science," London, Astronomical Observations and Criticisms, Vols. LXXXVII-XC, 1907/09

"Selected Chapters in Algebra" (with Drs. Metzler and Bullard), Longmans, Green and Co., 1907

"Wind Pressure on an Observatory Dome," Popular Astronomy, Vol. XVI, No. 7, 1908

"Observations and Measures of Double Stars," Astronomische Nachrichten, Kiel, No. 4259, 1908

"Some Observations of Double Stars," Popular Astronomy, Vol. XVII, No. 2, 1909

"Measure of Double Stars," Astronomische Nachrichten, No. 4338, 1909

"Some Thoughts on Space," The Mathematics Teacher, Syracuse and Lancaster, Vol. II, No. 1, 1909

"On the Extension of the Exponential Theorem," American Mathematical Monthly, Vol. XVI, Nos. 6-7, 1909

"College Algebra" (with Drs. W. H. Metzler and W. G. Bullard), Longmans, Green and Co., 1908

"New Double Stars," Astronomical Journal, Albany, N. Y., No. 611, 1910

"Achromatic and Apochromatic. Comparative Tests," Popular Astronomy, Vol. XVIII, No. 4, 1910

"Double Star Measures," Journal Astronomique, Tome I, No. 4, 1910

"Measures of Double Stars," Astronomische Nachrichten, No. 4381, 1910

"New Double Stars," Popular Astronomy, Vol. XVIII, No. 6, 1910

"New Double Stars, and Double Star Work," Popular Astronomy, Vol. XVIII, No. 9, 1910

"A Generalized Definition of Limit," The Mathematics Teacher, Syracuse and Lancaster, Vol. III, No. 1, 1910

"New Double Stars," Astronomische Nachrichten, No. 4467, 1911

"Suggestions for a New Theory of Comets" (with Professor W. P. Graham), Astronomische Nachrichten, No. 4466, 1911

"A New Invariantive Function" Jahresbericht Deutschen, Mat. Ver., Leipsig, Band 20, No. 9-10, 1911

"New Double Stars," Astronomische Nachrichten, Kiel, No. 4544, 1911

"New Double Stars," Astronomische Nachrichten, Kiel, No. 4762, 1914

"Book Review," The Mathematics Teacher, March 1914

"The Conjunction of Jupiter and Venus," Astronomische Nachrichten, No. 4814,1915

"Lectures on Determinants. A brief course," Syracuse, 1915

"Lectures on Selected Topics in the Calculus," Syracuse, 1916

"New Double Stars and Measures of Double Stars," Astronomische Nachrichten, Kiel, February 1916

"Direct Micrometrical Observations of the Sun, Eclipse of June 8, 1918," Astronomical Journal, No. 744, 1918

"Measures of Double Stars," Astronomical Journal, No. 748, 1919

"New Double Stars," Astronomical Journal, No. 745, 1919

"Direct Micrometrical Observations of the Sun," Astronomical Journal, No. 769, 1920

"Recent Auroras and Sun Spots," Science, Vol. 15, No. 1324, 1920

"Review of Space and Time in Contemporary Physics; an introduction to the relativity theory by Moritz Schlick," Mathematics Teacher, Vol. 2, 1920

"Conservative Appreciation of Michelson's Interferometer," Popular Astronomy, Vol. 25, No. 9, 1921

"Henry Allen Peck Collection of Astronomical Works," Revised from Daily Orange, June 12, 1922

"Occultation du IIIe Satellite de Jupiter par la Terre," L'Astronomie, Vol. 37, No. 10, 1923

"L'Observations Roe," L'Astronomie, Vol. 38, No. 4, 1924

"Direct Micrometrical Observation of the Sun. Exact formulas," Astronomical Journal, No. 869, 1926

THE EARLIEST DAYS OF PI MU EPSILON

By Floyd Fiske Decker,*
Syracuse University

The need for securing a more responsive audience for the presentation of student mathematical papers at Syracuse University, well recognized by the faculty members, was made clear to the undergraduates by Professor Edward Drake Roe, Jr., early in the academic year 1913-14. He based his suggestions on the fact that the Mathematical Club, which would complete ten years of activity at the end of that year, should look forward to an even more active second decade. The club members accepted the challenge and turned promptly to the consideration of the problems involved. The Alpha chapter of Pi Mu Epsilon emerged.

The club meetings had consisted of two parts — the presentation of one or two mathematical papers and an aftermath of refreshments and social activities. There were no intellectual requirements for membership, and by 1913 it became evident that too many members were not really interested in mathematics. The more responsible members realized that action was necessary. After an academic year packed with suggestions, reports, deliberations, agreements and decisions, the fraternity was organized.

At the regular meeting of the club on November 17, 1913, a committee was authorized to arrange for a celebration to commemorate its tenth birthday. It was no coincidence that at the same meeting a second committee, with Professor Roe as chairman, was established to consider and report on a possible revision of the constitution of the club. Here Professor Roe had the opportunity to start his campaign for the

*Charter member.

establishment of a fraternity of exactly the kind he had in mind. Under his skillful leadership most of his ideas prevailed.

Following some meetings of the committee and a special meeting attended by the executive committee and representatives from the faculty, a report was made to the club on the eighth of December. The report suggested, in outline, four alternative steps to strengthen the organization:

1. To establish scholarship requirements for membership in the club.
2. To reorganize the club as a professional fraternity.
3. To continue the club without change and to organize an honorary fraternity.
4. To provide within the club for the recognition of student performance by 1) barring freshmen, 2) accepting sophomores on probation, and 3) electing to full membership only those upper-classmen who establish satisfactory competence.

Alternative 2 was adopted and the committee was directed to draw up a skeleton constitution, — a result very pleasing to Professor Roe, as it was a first step toward his objective.

The committee again reported on the occasion of the regular meeting of the club on March 2, 1914. The report was not made to the club, however, but to a convention of those present since it was not yet known whether or not all members of the club would be permitted to join the fraternity if it should be established. The committee offered a constitution containing 13 articles and it was considered article by article.

The first article to be adopted was article 2 which read:

> "The first and primary aim of this fraternity shall be scholarship in all subjects and particularly in mathematics for the individual members and, secondly, the advancement of the science of mathematics and, lastly, the mutual mathematical and personal advancement of its members."

Next article 3 was revised and adopted in the following form:

"The charter members of the fraternity shall consist of those present members of the mathematical club of Syracuse University who have met all the requirements prescribed by the constitution of this fraternity and whose names follow."

A revision of article 4 was adopted reading as follows:

"Members of the faculty, graduate students and also those undergraduate students who are taking the equivalent of major or minor work in mathematics shall be eligible to membership in the fraternity."

With the revision of articles 12 and 13, articles 5 - 13 were adopted. Of these article 5 is significant in that it established the policy that no one was to become a member automatically by meeting the formal qualifications for membership. Election was necessary. Moreover by-law 2 stated that the affirmative vote of three-fourths of the voting members present was necessary for election. The presentation of article 5 divided the house into two nearly equal sets, the affirmative majority being due perhaps to the experience of some of the undergraduates with their social fraternities.

Articles 6 - 13 provide for the usual officers, the scholarship committee and amendments to the constitution.

Article 1, which gives the fraternity a name, was the last to be adopted (March 23). Several designations were discussed including:

1. ΕΠ (The promotion of scholarship)
2. ΕΠΜ (The promotion of scholarship and mathematics)
3. ΠΦΜ (Loving disciples of mathematics)
4. ΑΠ (Efficiency in all things)
5. ΜΡΒ (Mathematics the foundation of mental powers. These letters happened to be the first letters of the last names of three of the professors in the department.)

It was voted that combination 2 be adopted but that the order be changed to ΠΜΕ if that order were consistent with the above meaning, as it was in fact found to be.

At this meeting the by-laws were adopted.

At the convention of April 27 officers for 1914-15 were elected, the choice of Professor Roe for director being an obvious recognition of the masterly way in which he had

presided over the deliberations of the group during the preceding months. At the same election I was given the opportunity of working with the group as vice-director. The offices of secretary and treasurer went to undergraduates.

Beginning in 1916 the highest official honor going to an undergraduate was the chairmanship of the committee on scholarship, a position which went to the senior major with highest average. The other two student posts on the scholarship committee were filled on the basis of grades except that both sexes were to be represented.

At the first regular meeting of the fraternity on October 5, 1914, the following scholastic standards for eligibility were established:

	Mathematics Average	General Average
Sophomore	82	75
Junior	80	72

At the first fall meeting of 1915, the requirements were raised 3 points in each bracket. On later occasions these were further raised until it became necessary to re-establish the Mathematical Club as an organization to meet the needs of majors and minors who were unable to qualify for election to the fraternity.

Furthermore a person once elected to membership could not rest on his record. He must maintain a satisfactory scholastic record, for at the meeting on March 15, 1915, a new rule placed on the inactive list those whose general or mathematical average fell below 70. Three members met that fate immediately. They found they were not dealing with an honorary fraternity.

A point of procedure is indicated in the minutes of the meeting of October 8, 1917. "Seventeen names were presented of students meeting the scholastic standard for election to membership. Thirteen of these were certified as meeting the requirement of majoring or minoring in mathematics or planning to do so. The student members of the scholarship committee were directed to contact the remaining four and learn of their intentions regarding the continuance of the study of mathematics. . . . Three of the four were found eligible and elected."

After the academic year 1914-15, the fraternity was definitely a functioning organization, most of the decisions having been made on such items as formal initiation ritual, die, seal, badge, colors, flower and shield.

At Professor Roe's suggestion a forward-looking charter was obtained, under the laws of the State of New York. The charter authorized, for example, the owning and operating of fraternity houses.

The stimulating effect of the organization on the position of mathematics on the campus and the vitalizing of contacts between the faculty and potential and actual majors and minors soon attracted the attention of other departments of our university and led to what is sometimes designated as "the sincerest form of flattery" — the founding of similar organizations in other departments.

After a four-year development on our campus we were highly gratified to witness the spread of the fraternity to other institutions, so that we became the Alpha chapter of a national organization of which we are very proud. We were delighted at the recognition accorded Professor Roe, as the first director-general.

We are deeply appreciative of the many ways in which the fraternity has been improved during the 45 years of its existence by many representative mathematicians throughout the land, but the surviving members of that Syracuse group of 1913-14 will understand my pleasure in reliving those days.

GREETINGS FROM THE DIRECTOR-GENERAL

Last December a meeting of the representatives of the chapters of Pi Mu Epsilon was held in Pomerene Hall of the Ohio State University in Columbus. At this meeting the opinion was advanced that our fraternity is now large enough and important enough to warrant the support of an official journal. This suggestion was greeted with considerable enthusiasm, and it was voted to appropriate a small sum of money for the publication of the first issue of such a journal. Whether or not there will be subsequent issues is a matter for the chapters to decide.

The fraternity is singularly fortunate in that Professor Ruth Stokes has consented to serve as editor and Mr. Howard C. Bennett as business manager. Both are from the New York Alpha Chapter and it seems particularly appropriate that the first home of our journal should be with the mother chapter at Syracuse.

It seems as if some unifying agent such as an official journal would benefit the fraternity. The forty-six chapters are independent organizations with the privilege of running their own affairs pretty much as they please, which situation is as it should be, since conditions are different at different universities. But there seems to be no good reason why each chapter should not be cognizant of what the other chapters are doing, their programs, prize competitions and other activities, as well as their problems and frustrations and how they meet them.

I am convinced that Pi Mu Epsilon has an important mission in American university life in pointing out to competent students the beauty and utility of mathematics and its related sciences, and in insisting that mathematics be accorded its rightful place in the curriculum. Among the sections of the American Association for the Advancement of Science,

mathematics has always been designated as Section A. Surely we can defend the thesis that mathematics deserves an important place in the education of every competent man and woman. By so doing we may fulfil the pledge which we made when we were initiated into the fraternity.

I wish to take this opportunity of congratulating the Editor and the Business Manager upon the fine magazine which they have produced, and of extending my best wishes to each chapter and to each member of our fraternity. May Pi Mu Epsilon continue to be a potent force for genuine progress in American education.

Cyrus Colton MacDuffee

A CERTAIN PROPERTY OF CONTINUOUS FUNCTIONS

By Melvin Hausner
Brooklyn College

This article considers a certain type of periodicity of functions. To be definite, we restrict ourselves to continuous functions $f(x)$ defined in the interval $0 \leq x \leq 1$. Given such a function we ask if it ever repeats itself, i.e. if there is an $h > 0$ and an x_1 such that $f(x_1) = f(x_1 + h)$. Is there a definite $h > 0$ such for all $f(x)$ there will be an x such that $f(x) = f(x + h)$? The answer is obviously no, for any increasing function never repeats itself. To eliminate this possibility let us further stipulate that $f(0) = f(1) = 0$ for all our functions $f(x)$.

We now phrase the question formally. Consider the class of all continuous functions $f(x)$ defined in $0 \leq x \leq 1$ such that $f(0) = f(1) = 0$. Henceforth, unless we say otherwise, we are restricted to this class of functions. We will say that $f(x)$ has a subperiod h, where $0 < h \leq 1$, when there is an x_1 such that $0 \leq x_1 < x_1 + h \leq 1$ and $f(x_1) = f(x_1 + h)$. We ask: Are there any numbers h which are subperiods of all functions? Of course $h = 1$ is one such number due to our restrictions on our functions. (Take $x_1 = 0$.) Are there any, other than $h = 1$? The answer is yes. In this article we prove that all of the numbers $1, 1/2, 1/3, \ldots, 1/n, \ldots$ are subperiods of all functions we consider and that no other number is a subperiod of all functions.

The proof will be in two parts. In part I, we show that $1/n$, where n is a positive integer, is a subperiod of any function. In part II we show that if a number k is not of this type, then k is not a subperiod of all functions.

I. Since the number 1 is a subperiod of all functions as stated before, we may assume that we are given a number $1/n$ with $n > 1$. Let us assume that there is a function $f(x)$

such that $1/n$ is not a subperiod of $f(x)$. This means that for any x such that $0 \leq x \leq 1-1/n$, $f(x) \neq f(x + 1/n)$. This will lead to a contradiction and the first part will be proven. First $f(1/n) = f(0 + 1/n) \neq f(0) = 0$. We may assume that $f(1/n) > 0$. (If $f(1/n) < 0$, we would consider the function $-f(x)$). Now $f(2/n) = f(1/n + 1/n) \neq f(1/n)$. We wish to show that $f(2/n) > f(1/n)$. If not, consider the case $f(2/n) < f(1/n)$. This will lead to a contradiction. For define $g(x) = f(x + 1/n) - f(x)$, where $g(x)$ is a continuous function in the interval $0 \leq x \leq 1/n$. Secondly $g(0) = f(1/n) - f(0) > 0$ and $g(1/n) = f(2/n) - f(1/n) < 0$ by our assumption. Thus $g(x)$ is positive at $x = 0$ and negative at $x = 1/n$. Because $g(x)$ is continuous in $0 \leq x \leq 1/n$ there is an x_1 between 0 and $1/n$ such that $g(x_1) = 0$. Thus we have $0 = g(x_1) = f(x_1 + 1/n) - f(x_1)$ or $f(x_1) = f(x_1 + 1/n)$ which contradicts our original assumption on $f(x)$. Thus $f(2/n) > f(1/n)$. In a similar way we may prove that $f(3/n) > f(2/n)$ and by induction that $f((i + 1)/n) > f(i/n)$ for $i = 0, 1, 2, \ldots, n-1$. Thus we have $0 < f(1/n) < f(2/n) < \ldots < f(n/n) = f(1) = 0$ yielding an obvious contradiction. Thus we have proven that there is no function which does not have $1/n$ for a subperiod or that every function has $1/n$ as a subperiod.

II. Now suppose that $0 < a < 1$ and that $a \neq 1/n$ for any integer n. We need show that a is not a subperiod of all functions which we consider. Equivalently, we need only produce one function $f(x)$ such that for all x, $0 \leq x \leq 1-a$, $f(x) \neq f(x + a)$. Then a will not be a subperiod of all functions. To this end, we go through a construction of such a function.

Define k to be the greatest integer such that $ka < 1$. (Such k exist and furthermore $k \geq 1$.) Then $(k + 1)\,a \geq 1$. But by our assumption on a the equality cannot occur and we thus have $ka < 1 < (k+1)\,a$ or $0 < 1-ka < a$. Call $p = 1-ka$.

We will now construct the function $f(x)$. Graphically, consider the three points $A(0, 0)$, $B(p, -k)$ and $C(a, 1)$. By drawing the straight lines AB and BC, we construct a function $f(x)$ defined in $0 \leq x < a$. (We surely do not have to give the explicit formula for $f(x)$!) Now extend $f(x)$ by stipulating that for all x we must have $f(x + a) = 1 + f(x)$. We leave it as an easy exercise to show that there is one and only one

function satisfying the conditions of extension. (In succession define $f(x)$ in $a \leq x < 2a$, $2a \leq x < 3a$, etc. and similarly for negative x.) Continuity of the extended $f(x)$ need only be verified at the integral multiples of a, and is easily done. By induction it is also rather easy to show that $f(x + na) = n + f(x)$ for all values of x. What of $f(1)$? The answer is $f(1) = f(p + ka) = k + f(p) = k + (-k) = 0$. And so the $f(x)$ defined only in the interval $0 \leq x \leq 1$ is a function of the type considered, since by definition $f(0) = 0$. This $f(x)$ cannot have a subperiod a, because for all x we have $f(x + a) = 1 + f(x) \neq f(x)$. The theorem is thus completely proved.

QUOTATION: "Of all the reciprocals of integers, the one that I best like is 1/0 for it is a titan amongst midgets"-

Ascribed to Sam Linial, CCNY, '49

NOTE ON THE PRODUCT OF POWER SUMS*

By J. S. Frame,
Michigan State College

1. Introduction. The fact that the square of the sum of the first n integers is equal to the sum of their cubes is but one of a number of interesting relationships between the products of power sums. For example, the fourth power of the sum of the first n integers is equal to the average of the sum of fifth powers and the sum of seventh powers.

In general, let $S_p(n)$, or just S_p, denote the sum of the p^{th} powers of the first n integers. It is known that $S_p(n)$ is a polynomial in n of degree p+1, with coefficients involving the Bernoulli numbers B_k, such that $S_p(0) = 0$, $S_p(1) = 1$. It is natural to expect that a product $S_p(n)S_q(n)$ of two polynomials of respective degrees p + 1 and q + 1 in n should be expressible as a linear combination of p + q + 1 such polynomials of degrees less than or equal to p 1 2. However, the expression for the product $S_p(n)S_q(n)$, for $p \geq q$, actually involves only [p/2] + 1 polynomials $S_k(n)$ all having subscripts of the same parity, and having numerical coefficients whose sum is one. The coefficient of S_{p+q+1} is [1/(p + 1)] + [1/(q + 1)]. For example:

(1) $S_1^2 = S_3$, $S_2^2 = \frac{2}{3} S_5 + \frac{1}{3} S_3$, $S_3^2 = \frac{1}{2} S_7 + \frac{1}{2} S_5$,

$S_4^2 = \frac{2}{5} S_9 + \frac{2}{3} S_7 - \frac{1}{15} S_5$;

(2) $S_1 S_2 = \frac{5}{6} S_4 + \frac{1}{6} S_2$, $S_1 S_3 = \frac{3}{4} S_5 + \frac{1}{4} S_3$,

$S_2 S_3 = \frac{7}{12} S_6 + \frac{5}{12} S_4$.

*Paper presented in April, 1949, at the meeting of the Michigan Section of the Mathematical Association of America at Detroit.

2. Polynomials which represent power sums. A simple derivation of the polynomials $S_p(n)$ is obtained by means of generating functions. The coefficient of $t^p/p!$ in

$$(3)\quad G(n,t) = e^{t} + e^{2t} + \ldots + e^{(n-1)t} + e^{nt}$$

is precisely $S_p(n)$. Hence, summing the geometric series on the right of (3) we have

$$(4)\quad \sum_{p=0}^{\infty} S_p(n)t^p/p! = (e^{nt} - 1)/(1 - e^{-t}) = G(n,t).$$

We are led to the two series expansions

$$(5)\quad \frac{t}{2}\coth\frac{t}{2} = \left[\frac{t}{1-e^{-t}} - \frac{t}{2}\right] = 1 + \frac{B_1}{2!}t^2 - \frac{B_2}{4!}t^4 + \frac{B_3}{6!}t^6 - \frac{B_4}{4!}t^8 + \ldots,$$

$$(6)\quad e^{nt} - 1 = (nt) + \frac{(nt)^2}{2!} + \frac{(nt)^3}{3!} + \ldots$$

The product of the two series (5) and (6) gives the following modification of (4).

$$(7)\quad (e^{nt}-1)\frac{t}{2}\coth\frac{t}{2} = \sum_{p=0}^{\infty}\left[S_p(n) - \frac{1}{2}n^p\right]\frac{t^{p+1}}{p!} + \frac{t}{2} = G(n,t) - \frac{1}{2}t(e^{nt}-1).$$

Comparing coefficients of t^{p+1} on both sides of (7) we have

$$(8)\quad S_p(n) - \frac{1}{2}n^p = p!\left[\frac{n^{p+1}}{(p+1)!} + \frac{B_1 n^{p-1}}{2!(p-3)!} - \frac{B_2 n^{p-3}}{4!(p-3)!} + \right.$$
$$\left. \ldots + \frac{(-1)^{k-1}B_k n^{p+1-2k}}{2k!(p+1-2k)!} + \ldots\right],$$

where the value $k = (p+1)/2$ is omitted. This may be written

$$(9)\quad F_p(n) = S_p(n) - \frac{1}{2}n^p = \frac{n^{p+1}}{p+1} + \sum_{k=1}^{[p/2]}(-1)^{k-1}\frac{B_k}{2k}\left(2k^p - 1\right)n^{p+1-2k},$$

where

(10) $B_1 = \frac{1}{6}, B_2 = \frac{1}{30}, B_3 = \frac{1}{42}, B_4 = \frac{1}{30}, B_5 = \frac{5}{66}, \ldots$

3. Products of power sums. Using (9) we write

(11) $S_p(n) = F_p(n) + \frac{1}{2}n^p, \; S_p(n-1) = S_p(n) - n^p = F_p(n) - \frac{1}{2}n^p.$

Then the product $S_p(n)\, S_q(n)$ can be obtained by summing a telescoping series of differences.

$$(12)\quad S_p(n)\, S_q(n) = \sum_{m=1}^{n} \left[S_p(m)\, S_q(m) - S_p(m-1)\, S_q(m-1) \right]$$

$$= \sum_{m=1}^{n} \left[\left(F_p(m) + \tfrac{1}{2}m^p\right)\left(F_q(m) + \tfrac{1}{2}m^q\right) - \left(F_p(m) - \tfrac{1}{2}m^p\right)\left(F_q(m) - \tfrac{1}{2}m^q\right) \right].$$

After simplifying and applying (9) we have

$$(13)\quad S_p(n) S_q(n) = \sum_{m=1}^{n} m^q F_p(m) + \sum_{m=1}^{n} m^p F_q(m)$$

$$= \sum_{m=1}^{n} \left[\frac{m^{p+q+1}}{p+1} + \sum_{k=1}^{[p/2]} (-1)^{k-1} \frac{B_k}{2k} \binom{p}{2k-1} m^{p+q+1-2k} \right]$$

$$+ \sum_{m=1}^{n} \left[\frac{m^{p+q+1}}{q+1} + \sum_{k=1}^{[q/2]} (-1)^{k-1} \frac{B_k}{2k} \binom{q}{2k-1} m^{p+q+1-2k} \right].$$

$$(14)\quad S_p(n) S_q(n) = \left(\frac{1}{p+1} + \frac{1}{q+1}\right) S_{p+q+1}(n)$$

$$+ \sum_{k=1}^{[p/2]} (-1)^{k-1} \frac{B_k}{2k} \binom{p}{2k-1} S_{p+q+1-2k}(n)$$

$$+ \sum_{k=1}^{[q/2]} (-1)^{k-1} \frac{B_k}{2k} \binom{q}{2k-1} S_{p+q+1-2k}(n).$$

The coefficients of $S_{p+q+1-2k}$ may be combined to give a total of $1+[p/2]$ terms if $p \geqq q$, with alternating signs after the second term. In particular for $p = q$ we have

$$(15)\quad S_p^2(n) = \frac{2}{p+1} S_{2p+1}(n) + \sum_{k=1}^{[p/2]} (-1)^{k-1} \frac{B_k}{k} \binom{p}{2k-1} S_{2p+1-2k}(n)$$

We note that since $S_p(1) = 1$, the sum of the coefficients of the various $S_k(n)$ on the right of (14) or (15) is equal to 1. The relations in (1) and (2) are special cases of (15) and (14).

Successive application of (14) gives a means of expressing a product of $S_k(n)$ with any number of factors as a linear combination of these power sums. For example:

$$(16)\quad S_1^4 = \frac{1}{2}(S_7+S_5);\ S_2^3 = \frac{1}{12}(4S_8+7S_6+S_4).$$

PROBLEM DEPARTMENT

This department welcomes problems believed to be new, and, as a rule, demanding no greater ability in problem solving than that of the average member of the fraternity, but occasionally we shall publish problems that should challenge the ability of the superior undergraduate or graduate student. Solutions of these problems should be submitted on separate, signed sheets within three months after publication. Address all communications concerning problems to the Editor.

1. Proposed by the Problem Editor

Prove the following construction for finding the radius of a circumference. With any point O on the circumference as center and any convenient radius describe an arc PQR, cutting the given circumference in P and Q. With Q as center and the same radius describe an arc OR cutting PQR in R, R being inside the circumference. Join P and R, cutting the given circumference in L. Then LR is the radius of the circumference. (This is known as Swale's construction, and is probably the simplest solution of the problem yet discovered.)

2. Proposed by the Problem Editor

Instrumental errors may often be made to react against themselves and automatically disappear. A simple example is the process of "double weighing," in which the effect of inequality in the arms of the balance is removed by weighing with the object first on one pan, then on the other, and taking an appropriate mean. Several texts say that the arithmetic mean should be taken. Show that this is not true, and find the correct mean.

3. Proposed by the Problem Editor

The lengths of the sides of a triangle are the roots of the cubic equation $ax^3 + bx^2 + cx + d = 0$. Find the area of the triangle.

4. Proposed by the Problem Editor

Towards the bottom of page 268 of Cajori's "A History of Mathematics" (1926) we find the following statements: "Napoleon proposed to the French mathematicians the problem, to divide the circumference of a circle into four equal parts by the compasses only. Mascheroni does this by applying the radius three times to the circumference; he obtains the arcs AB, BC, CD; then AD is a diameter; the rest is obvious." Show how the "obvious" part of the problem may be accomplished.

5. Proposed by P. M. Anselone, College of Puget Sound

If $$f(M,N) = M!(N+1)\sum_{i=0}^{M}(M+N-i)!/(M-i)!,$$

show that $f(M,N) = f(N,M)$.

6. Proposed by C. W. Trigg, Los Angeles City College

Starting with a straight edge, closed compasses, and two straight line segments a and b, construct the harmonic mean of a and b in the least number of operations. Changing the opening of the compasses, drawing a circle or the arc of a circle, and drawing a straight line are each considered an operation.

7. Proposed by Arthur Rosenfeld, N. Y. C.

Prove that $$\sum_{j=0}^{R}\binom{Q}{J}\binom{Q-j}{R-j}=\binom{Q}{R}2^R.$$

8. Proposed by R. T. Hood, University of Wisconsin

Consider the stereographic projection of a sphere onto a plane tangent to it at its south pole S, the center of

projection being the north pole N. Prove that every great circle on the sphere not passing through N is mapped into a circle whose center is on the line through N which is perpendicular to the plane of the great circle.

9. Proposed by the Problem Editor

If the bases of a prismatoid are equal in area, then so are the sections equidistant from the midsection.

10. Proposed by P. L. Chessin, Columbia University

Sum the series

$$a + (a + d)x + (a + 2d)x^2/2! + \ldots + (a + nd)x^n! + \ldots$$

11. Proposed by Frank Hawthorne, Hofstra College

A projectile in vacuo passes through two given points. Determine the locus of foci and of vertices of the parabolic trajectories.

Question: How many legs has a horse?
Answer: Twelve; two in front, two behind, two on each side, and one in each corner.

REPORTS OF THE CHAPTERS

(Send reports to Ruth W. Stokes, 15 Smith Hall, Syracuse University, Syracuse 10, New York.)

EDITOR'S NOTE. According to Article VI, Section 3 of the Constitution: "The Secretary shall keep account of all meetings and transactions of the chapter and, before the close of the academic year, shall send to the Secretary-General and to the Director-General, an annual report of the chapter activities including programs of meetings, results of elections, etc." The Secretary-General now suggests that a copy of the annual report of each chapter be sent to the Editor of the PI MU EPSILON JOURNAL. Besides the information listed above we are especially interested in learning what the chapters are doing by way of competitive examinations, medals, prizes and scholarships. Before the JOURNAL went to press, we received twelve of these annual reports, and they will be published in the chronological order in which they were received.

Beta of North Carolina, University of North Carolina

The North Carolina Beta Chapter held six regular meetings, including initiations and elections, during the academic year 1948-1949. The following papers were presented:

"Matrices with Integer Elements" by Fred Wright

"Elections, Probabilities, and Predictions" by Dr. George W. Nicholson, Department of Mathematical Statistics

" 'Mathematics and the Imagination' by Kasner and Newman" by Alex S. Davis

"Opportunities in Mathematics" by Dr. W. M. Whyburn, Head of the Department of Mathematics, U.N.C.

"Continuous Transformations — an Elementary Preview" by Dr. J. H. Roberts, Department of Mathematics, Duke University.

Officers for 1949-1950 are: Director, Paul Minton; Vice-Director, Bryan Gresham; Secretary, Emily Jones; Treasurer, George Caldwell.

Alpha of Montana, Montana State University

The Montana Alpha chapter held its first meeting during the academic year 1948-1949 February 3, when the director and the only remaining student member, Thomas Joyce, initiated nineteen new members. At the first regular meeting the following officers were elected: Director, David C. Lea; Vice-Director, Leonard Lust; Secretary, Donald R. Marshall; Treasurer, Professor T. G. Ostrom.

The following papers were presented during the remainder of the session:

"Careers in Science" by Professor G. D. Shallenberger

"Mathematics and Chemistry" by Ted Burton

"New Absorption Bands of the Hydrogen Molecule" by Paul Pfleuger.

The annual banquet was held on March 29, in the Student Union Building with Director David Lea serving as toastmaster.

For the May meeting the chapter and the Chemistry Club held a joint picnic.

Officers for 1949-1950 are: Director, John A. Peterson; Vice-Director, Donald C. Philips; Secretary, Donald R. Marshall; Treasurer, Professor T. G. Ostrom.

Alpha of Michigan, Michigan State College

Besides the annual fall and spring picnics and the annual banquet held in February, the Michigan Alpha chapter held 8 regular meetings during the academic year 1948-1949. The programs consisted of papers, short talks, and demonstrations on the following topics:

"Solution of Oblique Triangles without Tables" by Dr. H. E. Stelson

Three different solutions of a mathematical problem by James Collins, Alex Arnot, and Robert Houston.

Short talks on famous men in the history of mathematics by some of the 36 initiates at the time of their initiation.

"The Theory of Knots" by Dr. Nordhaus

"What is Infinity?" Philip Hartman and Edward Seligman

"Some Applications of Differential Equations" by Dr. R. V. Churchill (speaker at the annual banquet)

"Orthogonal Latin Squares in the solutions of problems" by Donald Wietake

"Right Triangles Inscribed in a Conic" by Dr. B. M. Stewart.

At the March meeting the following officers were elected: Director, Edward Seligman; Vice-Director, John Hoskins; Secretary, E. Terence DeBlock; Treasurer, Bernard Yemc.

Delta of New York, New York University

The activities of the New York Delta chapter for the academic year 1948-1949 included business, social and regular meetings at which the following talks were given:

"A Geometrical Approach to Self-Excited Oscillations" by Professor Kurt O. Friedrichs, Professor of Applied Mathematics

"New Electronic Devices" by Mr. William Sollfrey, graduate member of the Delta chapter

"Mathematical Concepts and Reality" by Professor Hofstadter, Associate Professor of Philosophy

"A Geometrical Approach to Ballistics Problems" by Mr. Samuel Karp, Instructor in Mathematics

"An Application of Tchebichev's Inequality" by Professor George Garrison, Professor of Mathematics, College of the City of New York

"Casualty Actuary: Salesman of Probabilities" by Mr. Thomas O. Carlson, Actuary of the National Bureau of Casualty Underwriters and Member of the Casualty Actuarial Society.

The annual banquet was held on May 14 at the Fifth Avenue Hotel. The guest speaker was Professor Morris Kline, Professor of Mathematics, Washington Square College. His topic was "Harmony of the World."

A total of 28 new members were inducted into the chapter during the year.

Officers for 1949-1950 are: Director, Paul Gray; Vice-Director, Solomon Ciolkowski; Secretary-Treasurer, Miss Arlene Layton; Faculty Adviser and Permanent Secretary, Mr. John Schoonmaker.

Alpha of Kentucky, University of Kentucky

The Kentucky Alpha chapter held eight regular meetings, including business meetings and elections, during the academic year 1948-1949. The following papers were presented:

"Mathematical Education in Europe" by Dr. Tadeusz Leser

"From Spherical Trigonometry to Plane Trigonometry" by Dr. Harold H. Downing

"On the Scadastic Curve of a Compound Surface" by Dr. Charles L. Riggs

"The Role of Mathematics in Atomic Energy" by Dr. Louis Pardue, Dean of Graduate School of the University of Kentucky

"Summation of Certain Finite Series with Integral Intervals of Differences" by Mr. Cordell B. Moore

"An introduction to Generalized Quarternion Algebras" by Dr. Nathan B. Allison.

At the initiation banquet, Dr. Sallie Pence gave a beautiful and delightful resumé of her recent trip in the West with artistically photographed and colored slides. New members were initiated at this banquet meeting.

Officers for 1948-1949 were: Director, Dr. Francis M. Pulliam; Vice-Director, Miss Elsie T. Church; Librarian, Mr. Achilles E. Foster; Secretary-Treasurer, Mr. Donald C. Rose; Permanent Corresponding Secretary, Dr. Paul P. Boyd.

Officers for 1949-1950 are: Director, Miss Elsie T. Church; Vice-Director, Mr. Wimberly Royster; Secretary, Mr. Ruric Cooper; Permanent Corresponding Secretary, Dr. Paul P. Boyd.

Membership: Number of active members at the beginning of the year, 26; number of members initiated during the year, 11; total membership in chapter since charter was granted, 240.

Beta of Wisconsin, University of Wisconsin

The Wisconsin Beta chapter held eight regular monthly meetings besides the initiation banquet held near the end of the academic year 1948-1949. Topics for the meetings were:

Election of officers and appointment of committees: President, James G. Renno; Vice-President, Herman J; Cohen; Secretary-Treasurer, Violet G. Hachmeister; Faculty

Adviser, Professor Robert E. Fullerton. Membership Committee: Professor R. E. Fullerton, Chairman; Professor C. C. MacDuffee, James G. Renno, Leonard E. Fuller, Margaret Waugh Maxfield. Program Committee: Richard V. Andree, Chairman; Gerald P. Dinneen, Augusta L. Schurrer.

Get-acquainted open-house for the mathematic faculty, graduate students, and guests.

"Computation by Punched Cards" by Fred J. Gruenberger

"Atomic Elements in Boolean Algebra" by Joseph H. Engel

"Duality in Differential Calculus and Projective Geometry" by Rodney T. Hood

"Loops and their Isotopes" by Donald A. Norton

"The p-adic and g-adic Number Systems" by Richard V. Andree.

Spring party. Director-General MacDuffee performed the ceremony in which 24 graduate students were initiated into the chapter. Bridge, dancing, and refreshments completed the evening. Chairman, Violet G. Hachmeister. Attendance, 85.

Initiation banquet. Professor R. E. Fullerton performed the ceremony in which 18 graduating seniors were initiated into the chapter. Professor Rudolph E. Langer presented a talk, "The Life of Euler." Chairman, Dorothy B. Smith. Attendance, 73.

Beta of New York, Hunter College of the City of New York

The New York Beta chapter chose as a subject for the year's study: "Highlights in the History of Mathematics as Reflected in Some of the Monumental Books." There were eight program meetings held and at each two persons from the chapter presented short talks on some phase of mathematical history, or its development.

Officers for 1948-1949 were: Director, Miss Carolyn Eisele; Vice-Director, Josephine Guaragna; Secretary, Rita Challenger; Treasurer, Arline Withrow; Corresponding Secretary, Estelle Rosen and Ruth Roberts.

Officers for 1949-1950 are: Director, Professor Jewell Hughes Bushey; Vice-Director, Ruth Grabenheimer; Secretary, Joan Salatino; Treasurer, Therese Schwarz; Corresponding Secretary, Shirley Schneiderman.

The number of members in residence in September, 1948, was 172, and 26 new members were initiated during the year.

The chapter had two initiation dinners, one in the fall and one in the spring. At the first, Professor Carl C. Boyer spoke on "The Greatest Analytic Geometer"; at the second, Professor Richard Courant spoke on "Existence and Construction in Mathematics."

Alpha of Nebraska, University of Nebraska

The Nebraska Alpha chapter held eight meetings including business meetings and two initiation banquets. The following talks were given:

"Special Theory of Relativity" by Professor Theodore Jergensen

"Boolean Algebra" by Eugene Luchei

"Quantum Mechanics" by Dr. Julian H. Cohn

"Calculating Machines" by Fred L. Pelton

"Television" by Instructor D. D. Holmes

"Murder Incorporated" by Dr. Frederick Ludwig.

Officers for 1948-1949 were: President, Marlin Kroger; Vice-President, William Bade; Secretary, J. Denny Cochran; Treasurer, Frederick Pelton. Dr. William G. Leavitt was the sponsor.

Officers for 1949-1950 are: President, Cecil Doubt; Vice-President, Robert Ceasari; Secretary, Donald G. Cochran; Treasurer, David Olive. The faculty adviser as last year is Dr. Leavitt.

Alpha of New Hampshire, University of New Hampshire

During the year 1948-1949 the New Hampshire Alpha chapter held eight meetings, including business meetings and the initiation banquet. The following talks and papers were given:

"Application of Differential Equations to Transient Analysis of Electrical Circuits" by Frederick Mindt

"Mathematics and Chemistry" by Paul Quinney

"The Golden Section" by Charles Block.

At the final meeting Herbert Elliot gave a discussion and showing of plates on the use of geometrical designs.

Officers for 1949-1950 are: Director, Herbert Elliot; Vice-Director, Janette Furman; Secretary, Henry Keniston; Treasurer, Charles Zecchini.

Three faculty members and twenty-three students were initiated into the fraternity at the initiation banquet.

Alpha of Alabama, University of Alabama

Two university-wide competitive mathematics examinations featured the activities of the chapter this year. In the advanced section Mr. Robert C. Asquith was judged the winner while Mr. Wallace D. Driggers was second. In the elementary division Mr. Walter Wilson won first prize and Mr. David K. Gleason was second. In both classifications the winners received twenty-dollar prizes while the runners-up won ten dollars.

Prizes were also awarded for the best student papers presented before the chapter during the year. Twenty dollars was won by Miss Ann Lutz who spoke on "A Refinement for Linear Interpolation" and Jack G. Caldwell won ten dollars for his paper entitled "The Abacus." Other student papers included "The Life of Fourier" by Mrs. Charlotte Speight, "Fourier Series" by Mrs. Martha Weeks, "Mathematical Mayhem" by Mr. Frank M. Butler. In addition the following papers were presented by faculty members: "Plane Areas by Complex Integration" by Professor J. D. Mancill, "Some Mathematical Spplications of the Cathode Ray oscilloscope" by Mr. Robert Whitehurst.

The social activities of the chapter were high-lighted by a Christmas party and a spring picnic.

The officers for 1948-1949 were: Mr. Robert Whitehurst, Director; Miss Ann Lutz, Vice-Director; Dr. Ferdinand Mitchell, Treasurer; Mr. Haskell Cohen, Secretary; Miss Ella Jones, Publicity Chairman; Dr. J. D. Mancill, Librarian; Miss Charlotte Evans, Social Chairman.

The officers for 1949-1950 are: Mr. Neal Rowell, Director; Mr. Frank M. Butler, Vice-Director; Mr. Ben A. Green, Treasurer; Dr. H. S. Thurston, Secretary; Mr. Clyde Wiley, Publicity Chairman; Dr. J. D. Mancill, Librarian; Miss Susie Lee Ward, Social Chairman.

Alpha of Iowa, Iowa State College

The Iowa Alpha chapter held regular meetings at least once each quarter during the year 1948-1949.

Entertaining skits were presented by the new initiates

at the initiation banquets (one in November, another in April). A total of 100 new members were initiated this year.

The following talks were given:

"Rayleigh Method of Solving Vibration Problems" by Mr. Payne

"Teacher Rating Functions" by Dr. Vinograde

"Statistical Analysis of Teacher Rating Functions" by Mr. Steel

"Student Life in India" by Dr. Seth.

Officers for 1948-1949: Director, William J. Ritts; Vice-Director, Mary Ann Paulu; Secretary, Everett F. Blizzard; Treasurer, Karl L. Conrad; Faculty Advisor, Ralph M. Robinson.

Officers for 1949-1950: Director, Mildred Bretnal; Vice-Director, Jand Lloyd; Secretary, Eleanor Johns; Treasurer, Theodore Willoughby; Faculty Adviser, Ralph M. Robinson.

Alpha of New York, Syracuse University

The New York Alpha chapter held seven regular monthly meetings during the year 1948-1949, one of which was given over to business which included plans for a mathematical contest to be held for high school students in Syracuse and, also, plans for the initiation banquet. Another meeting was that of the annual initiation banquet. At the meetings during the year the following papers were presented:

"Some Paradoxes in Mathematics" by Dr. Arthur N. Milgram

"Mathematics in History" by Dr. William P. Hotchkiss (Department of History), banquet speaker

"Mathematical Aspects of Engineering Economics" by Dr. Otway O'M. Pardee

"Mathematical Problems Solvable by Students" by Dr. Harry E. Goheen

"The Fundamental Theorem of Algebra" by Dr. Paul W. Gilbert

"Some Applications of the Calculus of Variations" by Dr. Eric Hemmingsen

There were 99 new members initiated into the fraternity, and at each meeting there was an average attendance of 70 persons present.

Officers for 1949-1950 are: Director, Robert Pennock; Vice-Director, Gerald Rausa; Recording Secretary, Constance Banta; Corresponding Secretary, Dorothy Purdy; Treasurer, Robert Cooper; Permanent Secretary and Librarian, Mrs. May N. Harwood; Faculty Adviser, Howard C. Bennett.

MEDALS, PRIZES AND SCHOLARSHIPS

EDITOR'S NOTE. At the Columbus meeting last December there was much discussion about what the chapters are doing in the interest of scholarship, both within their chapters for their members and also in the local high schools. The discussion centered around competitive examinations, prizes and medals. Several delegates told of what their home chapters were doing. Professor Tomlinson Fort reported that the chapter at the University of Georgia for several years had been sponsoring competitive examinations to discover outstanding high school students. Similar projects located in Chicago and New York City were cited. It was proposed that we try to interest some large industry in sponsoring a national scholarship award for Pi Mu Epsilon with a stipend of one hundred dollars or more.

Some of the chapters included in their annual reports their plans and results for such awards. Each chapter will undoubtedly be interested in learning what other chapters are doing along the line of prize competitions. So the editor makes the request that, in case the chapters vote to continue the publication, chapters offering prizes please write up their plans for sponsoring examinations as a basis for awards, and submit their plans for publication in this journal.

EXCERPTS FROM ANNUAL REPORTS OF PI MU EPSILON CHAPTERS (1948-1949)

"Efforts are under way to promote a team to represent Iowa State College in the annual Putnam Prize Competition." — Iowa Alpha Chapter.

"It was voted to award a prize to the regularly enrolled student receiving the highest over all grade in the four

freshman mathematics courses, 11, 13, 14, and 16. The prize is to be $10.00." ...

"Three students expressed their desire to attend the William L. Putnam Mathematical Competition held March 26. The club voted to pay up to $25.00 for expenses if these members participated. (Note: As the competition was held in Durham, N. H., no expenses were necessary.)" — New Hampshire Alpha Chapter.

Please see Alabama Alpha's "Annual Report, 1948-1949," this issue, for report on competitive examinations and prizes.

"Nebraska Alpha Chapter sponsored classes to extend aid in mathematics to the slower students. Members of the chapter volunteered their services. This plan proved highly satisfactory, benefitting both the students seeking aid and also the members tutoring." ...

"The chapter prepared a pamphlet which is an introduction to Pi Mu Epsilon for students who are not familiar with the organization. The pamphlets will be distributed to all students in the lower mathematics classes." ...

"The annual Freshman and Sophomore competitive mathematics examinations were held April 30, 1949. The sophomore award was won by Robert Kleppinger, who also won the freshman award last year. Chris Kuyatt was the winner of the freshman award." — Nebraska Alpha Chapter.

"Dr. J. S. Frame presented the L. C. Plant awards to Ronald Eagle and Edwin Crosby." — Michigan Alpha Chapter.

"Pi Mu Epsilon entrance prizes, in the amounts of twenty-five, fifteen, and ten dollars, given on the basis of an examination offered to freshmen from Montana High School, were awarded this year to Mr. Thronson, first place; Mr. Wardahl, John Pecarich, and Keith Wilson, all tied for second place." ...

"The annual scholarship awards in the Mathematics and Physics Departments were this year awarded to Paul Rygg for outstanding work in the Mathematics Department and to Virgil Naumann for similar work in the Physics Department." — Montana Alpha Chapter.

"Mr. P. F. Conrad received the annual $25 Pi Mu Epsilon award for outstanding scholarship in mathematics while an undergraduate." — Illinois Alpha Chapter.

NEWS AND NOTICES

Since 1946 five new chapters have been installed: Pennsylvania Epsilon, Carnegie Institute of Technology (1947); North Carolina Beta, University of North Carolina (1948); New Hampshire Alpha, University of New Hampshire (1948); Virginia Alpha, University of Richmond (1948); and Ohio Delta, Miami University (1949).

An estimate of the total number of active members in Pi Mu Epsilon Fraternity for the academic year of 1948-1949 is 3740.

From the last annual report of the Iowa Alpha Chapter we learn: "The scholarship committee used the following requirements for eligibility for membership: (a) Completion of the calculus and in addition at least two courses for which the calculus is a prerequisite; (b) cumulative quality point mathematics average of at least 3.00; (c) cumulative quality point all-college average of at least 2.50. These requirements are over and above the minimum requirements as set forth in the by-laws of Iowa Alpha Chapter." ...

Also, in the same report we read: "The news of the proposed publication of a national journal by Pi Mu Epsilon was well received."

The North Carolina Beta report stated: "A dinner was held in the Student Union Building by the chapter in October, honoring Dr. and Mrs. W. M. Whyburn, Dr. and Mrs. I. R. Hershner, Mr. and Mrs. Fred B. Wright, and Mr. and Mrs. Isadore Blumen. Dr. Whyburn is the newly-appointed head of the Department of Mathematics at North Carolina. Dr. Hershner is a new member of the faculty of mathematics. Mr. Wright and Mr. Blumen were married just before the beginning of the school year. Both are members of the chapter here."

The Missouri Gamma Chapter, at St. Louis University, publishes quarterly an eight-page news letter, entitled THE MISSOURI GAMMA NEWS, with the subtitle, THE NEWS MAGAZINE OF THE MISSOURI GAMMA CHAPTER OF PI MU EPSILON.

During the meetings of the AMS and the MAA at the Ohio State University in Columbus, last December, Pi Mu Epsilon held a breakfast and short business meeting. At this meeting it was suggested that the fraternity undertake a publication. The suggestion was favorably received, and the delegates voted to appropriate a small sum of money for launching this project and trying it out for a year. This issue is the outcome. The mathematical organizations will hold their annual winter meetings this year in New York City, December 27-30, and, as usual, members of Pi Mu Epsilon who are present will be called together for an informal discussion meeting. It is earnestly hoped that before the meeting all members of the fraternity will make a careful study of the first issue of this experimental publication and that they will send delegates to the meeting in New York with instructions how to vote, that is, whether they wish to make the Pi Mu Epsilon Journal a permanent institution. If the chapters vote to continue the publication, the editorial staff would welcome suggestions for its improvement.

Just before the material for this publication went to press we received letters of acceptance from the three men who had been nominated for the editorial staff. We now have a corps of able associate editors; so, with full cooperation from all the chapters, we believe we can look forward with confidence to the future success of the PI MU EPSILON JOURNAL.

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MISCELLANEOUS

Kentucky Alpha Chapter of Pi Mu Epsilon

Dinner

Thursday, April 28, 1949

Menu

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Homogeneous amorphous masses of infinitesimal carbohydrate particles

Salad of

$$\frac{\pi}{4} \int_0^a \left(-1 + \sqrt{1 - 4x^4 + 4a^2x^2 + 4a^3x} \right) dx$$

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